POLICY BRIEF

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MINISTRY OF ENERGY AND MINERAL DEVELOPMENT

# Modelling the Macroeconomic Impacts of Renewable Energy Expansion in Uganda

## Abstract

Uganda committed itself to protect the climate and environment by signing the Paris Agreement and submitting the Nationally Determined Contributions that targets a low-carbon development pathway and reduction in the vulnerability of the population, environment, and economy. Therefore, expansion of renewable energy capacity as one of the strategies in the energy sector has significant mitigation potential. Government plans to increase the installed renewable energy capacity to 4,575 MW by 2040.

To explore possible benefits and challenges from this policy plan, the e3.ug model was applied to evaluate the socio-economic and environmental impacts.

The results from the simulation of this policy scenario with the e3.ug model indicate that renewable energy expansion is of advantage for Uganda. Economic, social, and environmental benefits are possible. Economic growth is accelerated, and additional jobs are created. Positive effects can be expected not only in manufacturing sectors directly profiting from the renewable energy expansion, but also income-induced impacts can be seen in agriculture, transport, and trade. However, policymakers should support the expansion of renewable energy sources to achieve these benefits and limit implementation barriers. This also includes support for the use of electricity e.g., in the industry and residential sector, which is not yet very widespread in Uganda.

## Introduction

The Ministry of Energy and Mineral Development (MEMD) of Uganda states in the updated energy policy the importance of sufficient, affordable, and reliable energy services to achieve sustainable development (MEMD 2022a).

At the same time, Uganda commits itself to protect the climate and the environment by signing the Paris Agreement and submitting the Nationally Determined Contributions (NDC). The mitigation potential of expanding renewable energy capacity in the energy sector is significant, considering the accelerated use of electricity and the possible offsetting of biomass burning and deforestation (MWE, 2015).

Significant progress has been made in expanding access to electricity. By 2020/2021, the national electricity access rate reached 58% and is expected to reach full coverage by 2040 (MEMD, 2022a, Uganda Vision 2040). Electricity demand is expected to grow continuously, and thus renewable energy must be further expanded to provide “green” electricity (MEMD, 2022b).

Uganda is richly endowed with renewable energy resources for energy production. At the end of 2021, the installed capacity of renewable energy was 1,246 MW of which hydro power accounted for 1,073 MW, Solar PV 61 MW, and biomass 112 MW.

Government plans to increase the installed renewable energy capacity to 4,575 MW by 2040 (MEMD, 2022b), which is also the basis for the expected expansion in the renewable energy scenario.

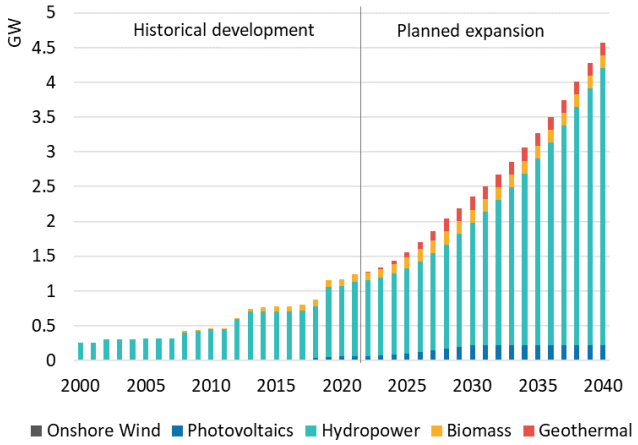



**Figure 1:** Historical and planned renewable energy expansion in Uganda. Source: GWS illustration based on IRENA, 2022; ERA, 2022

Depending on the renewable energy technology, government contributes to 15% to 40% of the investment. Remaining investments are covered by the energy sector.

The implementation of the envisaged renewable energy expansion is expected to exhibit various benefits for the economy and the environment. These impacts are

analysed with the e3.ug model to provide policy makers with an evidence-based analysis.

| Scenario | Key Assumptions |
|---|---|
| Renewable Energy Expansion | • Increase of RE generation capacity to 4,575 MW by 2040<br>• Additional capacity by 2040: hydropower 2,910 MW; solar PV 144MW, geothermal 183 MW, wind 20 MW, biomass 72 MW<br>• Investment costs per installed capacity: hydropower 1,950 USD/kW; solar PV 1,410 USD/kW; wind 1,660 USD/kW; biomass 4,060 USD/kW; geothermal 4,440 USD/kW |

**Table 1:** Key Scenario Assumptions

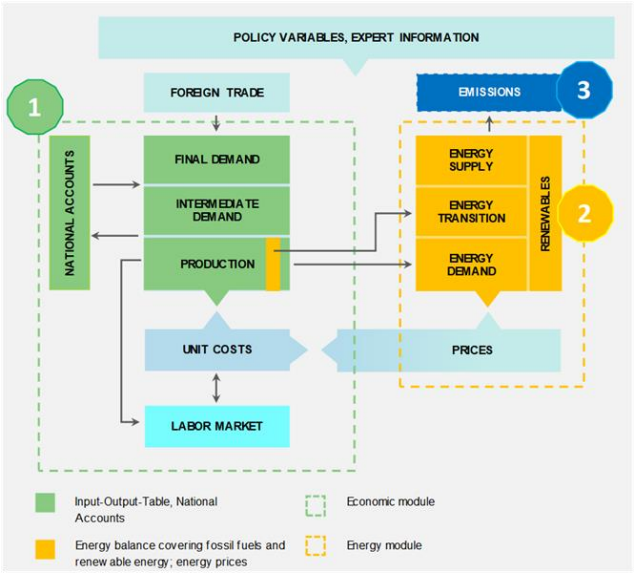
# Methodology

The e3.ug model is applied to study the economic impacts of energy transition scenarios. This policy brief presents the impacts of a renewable energy expansion scenario which are analysed by comparing them to the business-as-usual (BAU) scenario where renewable energy capacity is kept on a constant level from 2022 onwards. Grid expansion and improved grid access is part of the business-as-usual scenario.

**Figure 2:** e3.ug model at a glance. Source: Adapted from GWS, 2022

The e3.ug model covers the structure of the Ugandan economy and its main connections to the environment, i. e. the use of energy resources and the emission of greenhouse gas into the environment. Impacts for the whole economy, single economic sectors as well as on social balance and the environment can be quantified.

The model allows for discovering not only obvious direct




impacts but also impacts stemming from second round effects and feedback loops. This integrated modelling approach of the 3Es in one model assures a consistent view of policy scenarios.

# Key Findings

**1. The expansion of renewable energy has positive impacts in terms of GDP and employment.**

Investments in additional renewable energy capacity accelerate economic growth during manufacturing and installation as well as operation and maintenance with positive effects on employment and income. Hydro power, which is planned to be expanded the most, supports economic growth the most. Overall, UGX. 25,000 Bn. are needed for the envisaged renewable energy expansion by 2040.

Overall, GDP is up to 0.5% higher per year compared to a situation without further expanding renewable energy. The impacts on employment and income are positive enabling households to spend more on consumption. At maximum, 40,000 additional jobs (+0.2% p.a.) per year can be achieved.

Due to Uganda's dependence on imports, especially in the manufacturing sector, imports continue to rise (up to +0.8% p.a.), limiting economic growth.

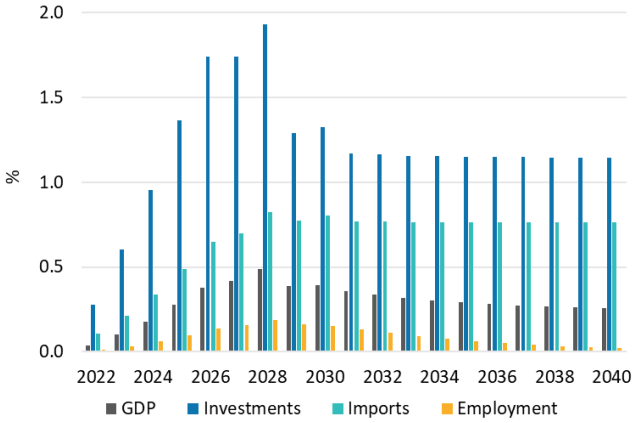



**Figure 2**: Macroeconomic impacts of renewable energy expansion (deviations in % from BAU scenario for selected years).

**2. Positive effects not only for directly affected economic sectors.**

Manufactured products – e.g., basic metals, concrete, construction activities as well as repair and installation of machinery and equipment, benefit directly and indirectly from the renewable energy expansion. An increase in economic activity and employment especially during the period of high investments until 2028 arises from all the three phases of the value chain of renewable energy deployment. These include manufacturing and installation as well as operation and maintenance.

Income-induced impacts allow for higher household consumption expenditures which induces additional jobs, in particular in the sectors of agriculture, forestry and fishing as well as trade and transport (**Error! Reference source not found.**).

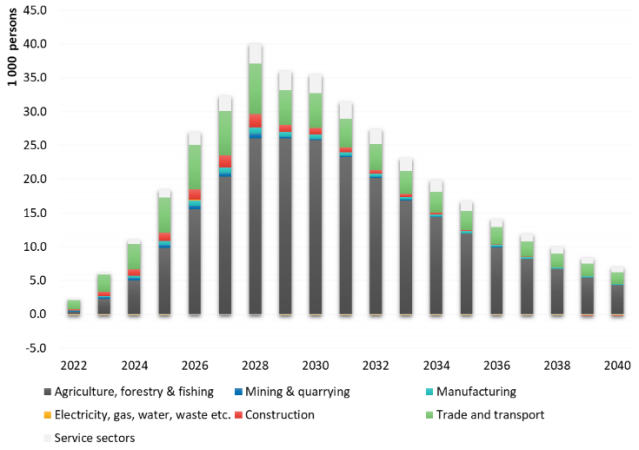



**Figure 3:** Impacts on employment by economic sectors of renewable energy expansion (deviations in % from BAU scenario for selected years).

**3. Expansion of renewable energy has the potential to enhance energy security and reliability.**

The use of various, decentralised renewable energy technologies makes the energy supply more robust and reliable. It reduces power outages caused by insufficient availability of one particular energy source, as other energy sources are available to generate electricity.

The expansion of renewable energy reduces dependence on fuel imports (such as oil products which currently must be fully imported), which may have a stabilising effect on the domestic economy by reducing its vulnerability to fluctuating world market prices. According to this scenario, imports of oil products (630 kiloton of oil equivalents) and biomass (2,412 kiloton of oil equivalents) can be reduced.

The expansion of renewable energy is also of great importance to provide electricity to households that do not have access to the grid (IRENA, 2019). Electricity from large power plants is usually distributed to consumers through the grid which can be costly in particular in sparsely populated areas. Solar PV in form of solar lanterns and solar lighting system offers a more affordable off-grid solution to rural households which also supports the achievement of 100% electricity access in Uganda (Ricardo, 2021).

**4. Renewable energy expansion mitigates emissions.**

Using non-biomass based renewable energy such as hydro power instead of fossil fuels and biomass to generate electricity reduces greenhouse gas emissions, protects nature, limits deforestation, and preserves carbon sinks. By 2040, 6.5 Tg greenhouse gas emissions (in relative terms about 5%) are expected to be saved compared to the BAU scenario due to the planned renewable energy expansion. 5 Tg $CO_2$ emissions out of 6.5 Tg are accounted for in forest land.

In the analysed scenario, all other sectors such as transport, manufacturing and construction emit more due to higher economic activity. No additional mitigation measures such as efficiency improvements or an increased use of renewable energy for these sectors are presumed in this scenario. Thus, the rebound effect resulting from higher economic activity and the associated increased energy consumption curtails to a very limited extent the reduction of the greenhouse gas emissions.

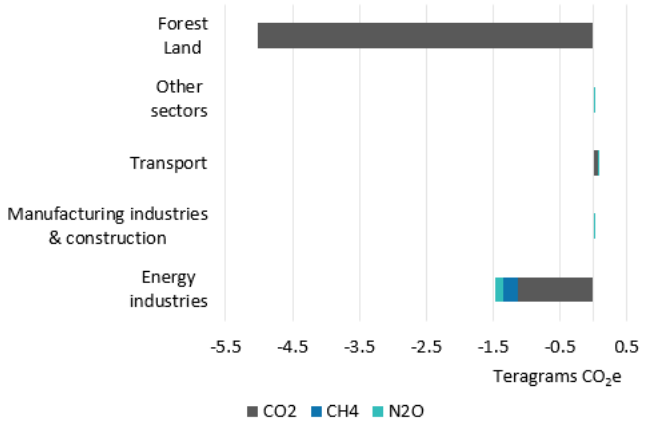



**Figure 4:** Impacts on greenhouse gas emissions (deviations in % from BAU scenario in 2040).

# Policy Recommendations

The results from the scenario analysis with the e3.ug model indicate that renewable energy expansion is of advantage for Uganda. Economic, social, and environmental benefits are possible. To achieve these benefits, policy makers are advised to support the expansion of renewable energy sources by:

**1. Promote renewable energy resources**

(i) Reduce financial barriers to encourage the renewable energy expansion. Funding from the government may reduce the financial burden for electricity producers and thus, limit the electricity price increase from which energy consumers will benefit.

(ii) Attract international donors and carbon offsetting projects to generate additional financial resources. At the COP27, developed countries promised to donate 100 Bn USD p.a. for adaptation and mitigations projects in developing countries.

**2. Boost local production and capacity building**

(i) Promote suitable local manufacturing capabilities to manufacture and install renewable energy technologies for example through the use of available resources to produce solar panels. Import dependency can thus be curbed.

(ii) Training of local employers to maintain and operate renewable energy systems independently. Foreign partnerships may help to build up capacities.

**3. Increase the resilience of the energy infrastructure**

(i) Expand several renewable energy technologies such as hydro power, solar photovoltaics, geothermal etc. to reduce dependency from a single renewable energy technology.

(ii) Wherever feasible and reasonable with regard to energy demand, plan the expansion of renewable energy technologies across the country to reduce the vulnerability from local climate hazards.

(iii) Protect the electricity generation system and grid infrastructure from known climate change impacts such as droughts and floods.

# Conclusion

Uganda is richly endowed with multiple renewable energy resources for electricity production which makes the envisaged renewable energy expansion possible. Additionally, the renewable energy expansion increases the gross domestic product which is up to 0.5% higher per year compared to a situation without further expanding renewable energy, creates 40,000 jobs, and saves 6.5 Tg greenhouse gas emissions.

The renewable energy expansion comes at costs which should be at least partially financed by the government and / or international donors to limit electricity price increases.

To exploit the full benefits of an increased use of "green" electricity should be promoted and financially supported. The economic and environmental benefits would be even better than those presented in this policy brief.

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